Title of the Invention

Method of making Golf club head

Background of the invention

The present invention relates to a method of making a golf club head, more particularly to a method of welding metal parts of a club head.

In the golf club heads made up of two or more metal parts such as metal wood-type head and iron-type head, such metal parts are usually connected with each other by one side welding of butt joint, and in recent years, the use of laser welding instead of the widely employed tungsten inert gas (TIG) welding has been suggested or proposed in the Japanese patent No.2600529 and laid-open Japanese patent application JP-A-2001-293115.

On the other hand, in case of metal wood-type club heads for example, the golfers have a tendency to prefer the recent large-sized heads. Thus, the wall thickness in the welded place of such a large-sized head also has a tendency to decrease. Further, to achieve the desired performance (strength, weight and the like), the use of different metal materials is preferred. Therefore, if such metal parts are, as shown in Fig.13(a), temporally butt jointed and a laser beam is applied to the joint part, a joint dent (g) is very liable to occur as shown in Fig.13(b). As the wall thickness is relatively small, the joint dent (g) greatly decrease the joint strength. Further, as the wall thickness is small, if the laser beam is penetrate through the joint part, there is a possibility that the molten material trickles down towards the backside hollow, causing the shortage

of the filling material. Thus, the possibility of occurrence of pinholes is also high.

Summary of the Invention

It is therefore, an object of the present invention to provide a method of making a golf club head by which the joint dent can be effectively prevented to reduce poor weld and improve the joint strength as well as the appearance around the joint part, and thereby the productivity can be greatly increased.

According to one aspect of the present invention, a method of making a golf club head which head comprises two metal parts connected each other by welding their opposite surfaces comprises

making the two metal parts, wherein at least one of the two metal parts is provided with a small protrusion along the surface to be welded, and

laser welding the opposite surfaces by applying a laser beam to at least the protrusion so that the molten material of the protrusion penetrates into a gap between the opposite surfaces to connect the two metal parts each other.

Brief Description of the Drawings

Fig.1 is a perspective view of a wood-type golf club head according to the present invention.

Fig.2 is an exploded perspective view showing a two-piece structure for the wood-type golf club head.

Figs.3, 4, 5 and 6 are cross sectional views each showing a structure of a welding part of the club head according to the present invention.

Fig.7 is an exploded sectional view of another example of the two-piece structure for the wood-type golf club head.

Fig.8 is an enlarged sectional view showing a modification of the welding part shown in Fig.7.

Fig.9 is an exploded sectional view of showing a three-piece structure for the wood-type golf club head.

Figs.10 and 11 are cross sectional views each showing an iron-type golf club head according to the present invention, taken along a vertical plane passing the center of the club face.

Figs.12(a), 12(b) and 12(c) are enlarged sectional views to explain the laser welding according to the present invention.

Figs.13(a) and 13(b) are enlarged cross sectional views for explaining the problem arising when one side laser welding of butt joint is applied between thin metal parts.

Description of the Preferred Embodiments

Embodiments of the present invention will now be described in detail in conjunction with the accompanying drawings.

Wood-type head

Fig.1 shows a metal wood-type hollow golf club head 1 according to the present invention, which comprises a face portion 2 having a front face defining a club face F for hitting a ball, a crown portion 3 intersecting the club face F at the upper edge Ea thereof, a sole portion 4 intersecting the club face F at the lower edge Eb thereof, a side portion 5 between the crow portion 3 and sole portion 4 extending from the toe side edge Ec to the heel side edge Ed of the club face F, and a neck portion 6 with a cylindrical bore for receiving a golf club shaft

(not shown).

The wood-type club head 1 is formed by laser welding two or more metal parts P (P1, P2 --) together.

As to the materials of the metal parts P, various metallic material may be employed such as titanium alloys, pure titanium, stainless steel, aluminum alloys, SC steel, maraging steel, magnesium alloys, copper alloys and titanium-zirconium alloys. Since the laser welding method is employed, it does not matter whether the welded metal parts P are the same or different in the material or alloy's major component.

Two-piece structure 1

Fig.2 shows an example of two piece structure for the head 1, which comprises a first metal part P1 for forming an open-front head main 1a including the crown portion 3, sole portion 4, side portion 5 and neck portion 6, and a second metal part P2 which is a face plate 1b for forming the almost entirety of the face portion 2. The face plate 1b is attached to the front of the head main 1a so as to close a front opening O thereof.

The head main 1a is, as shown in Fig.2, provided along the internal circumference of the opening O with one continuous protrusion or a plurality of discontinuous protrusions 9 for the purpose of supporting as well as positioning the backside of the face plate 1b.

The face plate 1b is shaped to accommodate the opening O to fit in snug or loose therewith when the face plate 1b is put in the opening O, and as shown in Fig.3, the gap D between the opposite surface 10 and 11 of the two metal parts P to be welded is preferably set in a range of from 0.1 to 0.5 mm, more

preferably from 0.1 to 0.3 mm.

According to the present invention, along one of or each of the opposite surface 10 and 11 to be welded, a small protrusion 7 which functions as a filler rod is continuously formed. Figs.2, 3, 4 and 5 show examples in which a protrusion 7 is formed along only one of the opposite surface 10 and 11. Fig.6 shows an example in which a protrusion 7 is formed along each of the opposite surface 10 and 11. In these example, the protrusion 7 protrudes from the outer surface 12 more specifically front surface F of the head 1, while tapering through to the extreme end.

The protrusion 7 has a surface 7a as an extension of the surface 10/11 beyond the outer surface 12, and a surface 7b inclined towards the surface 7a while extending from the outer surface 12 towards the end of the surface 7a. In the drawings, the surface 7a is depicted as straight and aligned with the surface 10/11 in the cross section perpendicular to the surface 10/11 and also to the longitudinal (circumferential) direction of the surface 10/11. However, as far as the insertion of the face plate 1b to the opening O is not hindered, the surface 7a may be slightly curved and/or inclined. On the other hand, as the inclined surface 7b will not hinder the insertion, it may be straight (as depicted in the drawings) or bent or concave or convex. Therefore, various shapes, e.g. a triangle such as right triangle, quadrant, trapezoid and the like may be employed as the cross sectional shape of each protrusion 7. In the example shown in Figs.2 and 3, a protrusion 7 having a substantially triangular cross sectional shape is formed annularly along the circumferential surface 10 of the opening O and integrally with

the head main 1a by casting.

In the example shown in Fig.4, a protrusion 7 which is provided with a trapezoidal cross sectional shape having a straight side (the surface 7a), an inclined side (the surface 7b) and an additional side 7c (surface perpendicular to 7a) is formed in the same way as in the former example.

In contrast to the former to examples, in the example shown in Fig.5, a triangular protrusion 7 is formed on the second metal part P2, namely the face plate 1b, annularly along the circumferential surface 11 of the face plate 1b.

The example shown in Fig.6 is a combination of the head main 1a (metal part P1) shown in Fig.3 and the face plate 1b (metal part P2) shown in Fig.5.

In the particular cases shown in Figs.3, 4 and 6, in order to facilitate the insertion of the face plate 1b to the opening, the surface 7a as an extension of the surface 10 of the opening may be inclined toward the outside so that such surface functions as a guide slope.

Two-piece structure 2

Fig.7 shows another example of the two-piece structure for the wood-type club head 1, which comprises a first metal part P1 for forming an open-top head main 1c including the face portion 2, sole portion 4, side portion 5 and neck portion 6, and a second metal part P2 which is a crown plate 1d for forming the almost entirety of the crown portion 3. The crown plate 1d is attached to the top of the head main 1c so as to close a top opening O thereof. Thus, the crown plate 1d is shaped to accommodate the opening O to fit in snug or loose therewith when the crown plate

1d is put in the opening O. In this example, a protrusion 7 is provided on the head main 1c only. The protrusion 7 is formed annularly along the circumferential surface 10 of the opening O and integrally with the head main 1c by casting. Further, similar to the former example, one or more protrusions 9 are formed along the opening O. The crown plate 1d is on the other hand, formed by press molding to provide a specific curvature. However, it may be also possible to employ another method such as casting.

Fig.8 shows a modification of the structure shown in Fig.8, wherein a protrusion 7 is provided on the crown plate 1d instead of the head main 1c. In this case, it is preferred that the crown plate 1d is formed by press molding to provide its specific curvature and to form the protrusion 7 at the same time. In this type of two-piece structure too, a protrusion 7 may be provided on each of the parts P1 and P2.

Three-piece structure

Fig.9 shows a three-piece structure for the wood-type club head 1, which comprises a first metal part P1 for forming an open-top-and-front head main 1e including the sole portion 4, side portion 5 and neck portion 6, a second metal part P2 which is the above-mentioned face plate 1b for forming the almost entirety of the face portion 2, and a third metal part P3 which is the above-mentioned crown plate 1d for forming the almost entirety of the crown portion 3. In this illustrated example, the protrusions 7 are formed along the two openings of the head main 1e as explained in the former examples.

Iron-type club head

Figs.10 and 11 show iron-type club heads 20 according to the present invention, wherein each head 20 comprises a head main 20a as one metal part P1 and a face plate 20b as one metal part p2.

In the example shown in Fig.10, the head main 20a is provided with an opening or hole penetrating therethrough from the front to the back of the head, and the face plate 20b is put in the opening to contact with the above-explained continuous protrusion 9 for the purpose of supporting and positioning the backside of the face plate 20b. The protrusion 7 is provided on the head main 20a only in the same way as in the example shown in Figs.2 and 3.

In the example shown in Fig.11, the head main 20a is provided with an opening or hole penetrating therethrough from the front to the back of the head, and the face plate 20b is shaped to accommodate the shape of the front of the head main and disposed directly thereon. The protrusion 7 is provided on the face plate 20b annularly along the circumference thereof.
In this example, in order to form a gap D, the outer circumferential edge of the font surface of the head main 20a is provided with a chamfer 16 formed by a double slope merging into a flat face contacting with the back face of the face plate 20b.

In these two examples, due to the through hole, a significant portion of the backside of the face plate 20b is exposed.

Making method

As described above, the metal parts P (P1, P2, P3 --) are

formed by appropriate methods, e.g. lost wax precision casting (head main 1a, 1c, 1e, 20a), press molding (face plate 1b, crown plate 1d), forging and the like, depending on the material, position, size, shape and the like of the part. In case of the face plate 1b, 20b, however, plastic forming such as cold forging and cold press working is preferably used because it is easy to control the crystallographic structure of the metal material in comparison with casting. In the foregoing examples, therefore, the face plate is formed by press molding to give a specific face bulge and roll.

According to the present invention, utilizing the above-mentioned protrusion 7, the opposite surfaces 10 and 11 of the metal parts P (P1, P2, P3 --) are laser welded.

Next, taking the structure shown in Figs.2 and 3 as an example, the laser welding according to the present invention will now be explained.

First, the metal parts P1 and P2 are temporarily fixed to each other, utilizing a holder or a self-retention force or another appropriate method. Then, as shown in Fig.12(a), using a laser beam machine (f), high-power laser beam such as CO_2 laser or YAG laser is applied to the protrusion 7 and the vicinity of the gap D to melt the metal materials near the surfaces 10 and 11. The molten metal materials 15 flow into the gap D as shown in Fig.12(b) and are fused to connect these two parts P1 and P2. After the welding is completed, as shown in Fig.12(c), the weld bead 14 or swelling part on the head outer surface 12 formed along the welded place 13 by the overflow is removed by grinding or the like and further the surface is polished.

If the volume of the protrusion 7 is too small, a dent along the welded place 13 is formed. If the volume is too large, the applied heat is dispersed and a higher power laser is required, and as a result, the crystallographic of the metal is liable to alter partially. Therefore, to achieve the most effective results in the welding process, as shown in Fig.3, the height H of the protrusion 7 is preferably set in a range of from 0.3 to 1.0 times, more preferably 0.4 to 0.7 times a thickness (t) of one of the metal parts P1 and P2 which is not larger than the thickness of the other, when measured at the positions of the surfaces 10 and 11, excluding the protrusion 7 by extending the adjacent outer surface 12 of the head along its course. Further, the maximum width W of the protrusion 7 which occurs at the outer surface 12 is preferably set in a range of from 0.5 to 2.0 times, more preferably 0.7 to 1.5 times the height H when measured in parallel with the outer surface 12.

If the gap D is too narrow, it is difficult for the molten metal to penetrate into the gap, which results in a longer laser beam applying time. This is not desirable in view of prevention of the undesirable alternation in the metal structure. Further, as a high degree of precision is required, in view of the production efficiency, production cost and the like, the excessively narrow gap is not desirable. On the other hand, if the gap D is too wide, the molten metal is liable to trickle down and it becomes difficult to bridge the gap. Therefore, the gap D is preferably set in a range of from 0.1 to 0.5 mm, more preferably from 0.1 to 0.3 mm.

Additionally, if the thickness (t) is relatively large, to facilitate the reaching of the laser beam to a deeper point of

the gap in the initial stage of the laser applying, and also to facilitate the reaching of the molten metal to the bottom of the gap, a chamfer 16 is preferably provided on the corner on the opposite side of the protrusion 7 as shown in Fig.5 by chain line for example.

In the foregoing examples, the protrusion 7 extends continuously through its overall length, but the protrusion 7 may be provided with discontinuity as far as the shortage of the molten metal is not caused thereby.

Comparison test

Metal parts having the specification given in Table 1 were made and laser welded to produce 100 pieces of golf club heads. Then, the welded place was observed visually to check the occurrence of dent. The results are shown in Table 1.

From the test results, it was confirmed that in the golf club heads Ex.1 - Ex.5 according to the present invention, the occurrence of dent was effectively reduced, when compared with golf club heads Ref.1 - Ref.5.

Table 1

Club head	Ex.1	Ex.2	Ex.3	Ex.4	Ex.5	Ref.1	Ref.2	Ref.3	Ref.4	Ref.5
Structure	Fig.2	Fig.9	Fig.7	Fig.10	Fig.11	Fig.2	Fig.9	Fig.7	Fig.10	Fig.11
Head main (casting) Material	crown+sole +side+neck titanium alloy	sole+side +neck titanium alloy	face+sole +side+neck stainless	stainless	stainless	crown+sole +side+neck titanium alloy	sole+side +neck titanium alloy	face+sole +side+neck stainless	stainless	stainless
Face plate Material	press molding titanium alloy	press molding titanium alloy	-	casting stainless	casting stainless	press molding titanium alloy	press molding titanium alloy	-	casting stainless	casting stainless
Crown plate Material	-	press molding titanium alloy	casting stainless	-	-	-	press molding titanium alloy	casting stainless	-	-
Thickness t (mm)	2	face 2.0 crown 0.8	0.6	2	2	2	face 2.0 crown 0.8	0.6	2	2
Protrusion Height H (mm)	1.2	face1.2 crown0.8	0.6	1.2	1.2	0	0	0	0	0
Width W (mm)	1	1.0/1.0	1	1	1	0	0	0	0	0
Rate of occurrence of dent (%)	0.5	0.5	0.5	0.5	0.5	65	77.2	23.4	48.9	51.6